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(54) Title: WIRE COATING COMPOSITION

(57) Abstract

A wire coating composition comprises 100 php (parts per hundred parts of polypropylene) polypropylene polymer or copolymer, 1 to 20 php of polyethylene wax and 100 to 200 php of magnesium hydroxide which is provided with a hydrophobic coating. The wire coating composition does not contain any halogen and is essentially free of phosphorous and phosphorous salts.

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WIRE COATING COMPOSITION

The present invention relates to a wire coating composition. The term "wire" used herein embraces both wires and cables.

It is conventional to provide a polymeric insulation coating around wires and cables. Such coatings are often made from halogenated polymers, such as polyvinyl chloride (PVC). The main problem of PVC and other halogenated polymers is that upon combustion a large volume of toxic, acidic and highly corrosive hydrogen halide smoke is liberated. As a consequence halogen-free polymer compositions for coating cables or wires have been developed. Examples of such compositions are included in EP 082407A, EP 488381A and US 5032321. These and other prior art halogen-free coating compositions, which are based upon thermoplastic polymer/mineral filler mixtures, possess inadequate abrasion resistance, electrical insulation properties and temperature stability. These coating compositions have a maximum temperature range of only 70-80°C. Furthermore, the extrusion speed for compositions of the type disclosed in EP 082407A, EP 488381A and US 5032321 may only be one fifth of that for PVC. Similar compositions containing intumescent system flame retardants, such as ammonium polyphosphate, have also been shown to exhibit inadequate electrical resistance due to the fact that the flame retardant attracts moisture and therefore increases the electrical conductivity of the material. It is noted that conventional phosphorous-based flame retardant compounds are contained in relatively large amounts, usually

up to 40 php for ammonium polyphosphate.

A disadvantage with red phosphorous-based system is that the cable coatings have a strong red colouring, which is disadvantageous for electrical cable coatings in general.

The aim of the invention is to provide a recyclable and/or reprocessable halogen-free coating composition with improved abrasion resistance, electrical insulation and temperature resistance properties without a deterioration in other physical properties, such as tensile strength or flexibility.

According to the present invention there is provided a wire coating composition comprising polypropylene polymer or copolymer, polyethylene wax and magnesium hydroxide provided with a hydrophobic coating and wherein the wire coating composition does not contain any halogen and is essentially free of phosphorous and phosphorous compounds and phosphorous salts.

The term "essentially" is used herein to mean that the composition is free from "phosphorous" or compounds or salts thereof or has a phosphorous content of less than 800 ppm.

The wire coating composition of the present invention exhibits the required coating characteristics, but unlike some PVC compounds is readily recyclable. The coating composition of the invention further provides the required electrical insulation, while being flexible, flame resistant, heat stable to greater than 125°C, abrasion resistant, readily extrudable and recyclable.

The components of the composition are ideally present in

the following ratio:

polypropylene	100 php (parts per hundred polypropylene);
magnesium hydroxide (coated)	100 to 200 and ideally substantially 140 php; and
polyethylene	1 to 20 and ideally substantially 10 php.

The coating compositions are particularly useful for wires in motor vehicle engines, such wires being subjected to high temperatures and contact with water and fluids such as petrol, diesel, oil, salt solution and anti-freeze. It is necessary for wire coating materials under vehicle bonnets to have a temperature rating of greater than 100°C, at which temperature the coating should remain stable and retain electrical insulation properties. The coating compositions according to the invention possess a temperature rating of greater than 125°C.

Polyethylene wax is incorporated to improve abrasion resistance. Hard high molecular wax components would provide excellent abrasion resistance, but would also increase the tendency for stress cracking of the coating to occur. Being a relatively low molecular weight material, polyethylene wax enhances abrasion resistance of the coating without having an adverse effect on other coating properties.

The magnesium hydroxide acts as a filler and flame retardant. In order to overcome the problems of moisture attraction associated with intumescent flame retardant systems, the magnesium hydroxide particles are coated with a

hydrophobic material such as an alkyl silane, for example a trimethoxysilane or triethoxysilane. The coating enhances adhesion between the filler particles and the polymer matrix, improves the abrasion resistance of the coating and most importantly, due to its hydrophobic nature, increases the resistance of the coating to moisture entrapment thereby maintaining electrical insulation properties. Magnesium hydroxide is also stable at high temperatures, whilst its low surface area gives it a low viscosity. It is therefore easy to process.

The preferred amount of 140 php magnesium hydroxide content gives the ideal balance between flame retardance and flexibility. A high filler content gives excellent flame retardance. However, at the same time the coating will become much less flexible such that the coated wire will fail a standard conductance test whereby a wire is tightly coiled (typically around a 1mm diameter mandrel) and stored in hot water (normally 80°C) whilst under high voltage. If the coating is not flexible enough then it will crack at the coil heads.

A further advantage of the compositions according to the invention is that they can be extruded onto wire or cable using existing extrusion equipment at speeds similar to that of PVC coatings.

A cost saving may be made by using the coating compositions of the invention using the high temperature rating of the coatings. Normally a copper wire becomes hot due to the conduction of the electrical current. The high

temperature rating of the coating means that thin layers of coating can be used on thin wires, representing a saving of expensive copper.

A preferred embodiment of the invention involves the incorporation into the composition of a synergistic blend of an anti-oxidant derived from phenol and anti-oxidant based upon a phosphite. Such anti-oxidants are present in an amount of only 0.1 to 0.5 php. Such phosphite contents are sufficiently low (770 ppm) to have a negligible moisture attraction capability. In such compositions good processability is retained without adversely effecting the other physical properties of the coating. This aids further reprocessing of the coatings and therefore improves the recyclability of the compositions.

The polymeric composition of the invention may optionally further comprise additives such as stabilisers, plasticisers, lubricants and further flame retardants.

In order that the invention may be more readily understood specific embodiments of the invention is now described in detail.

Example 1

Composition: 100 php propylene polymer[1]

140 php Magnifin H5KV[2] coated with AMEO-T[3]

5 php polyethylene wax[4]

1 polymer comprises 20 php Appryl 3060 MMS (tradename of Atochem for a propylene copolymer) and 80 php Moplen D50-G (tradename of Himont for a propylene homopolymer). Appryl 3060 MMS has a melt flow index of 0.5g per minute at 230°C and

21.6 kg. Moplen D50-G has a melt flow index of 0.3g per minute at 230°C and 21.6 kg.

2 magnesium hydroxide - a tradename of Martinswerk.

3 octyl triethoxy silane coupling agent, a tradename of Hüls.

4 The trade name of the wax is A-C 9/9A (tradename of Allied Wax). This has a drop point of 115°C and a density of 0.93 g/cm^3.

The composition was extruded onto a standard metal wire used for automotive electrical cable applications, at a rate of about 700 m per minute, using the normal extrusion equipment for PVC-coated cables, to form a coated cable with a cross-sectional area of $2.5mm^2$. Such cables would commonly be used as alternator or battery leads in a motor vehicle engine.

The test results for the coating are as follows:-

Test	Requirement	Standard	Results
Insulation	Conductive cross-sectional area of 1.5 - 2.5 mm^2 under a load 10 - 80 N	DIN 72551 Point 3.3.2	39 N
Abrasion Behaviour measured in terms of the number of hub cycles to retain a min. thickness of 2.5 mm^2	1500 cycles	DIN 72551 Point 3.3.3	> 3000
Heat Resistance Under Load (measured as the penetration depth into the coating after heating for 4 hours at 125°C	0.15 mm	DIN 72551 Point 3.4.2	> 0.25 mm
Max. Thermal Shrinkage	4 %	DIN 72551 Point 3.4.2	2.5 %
Voltage Strength for 30 minutes	5 KV	DIN 72551 Point 3.5.3	passed
Min. Specific Resistance at 70°C	10^{10} ohms per cm	DIN 72551 Point 3.6.1	3.2×10^{14}
Thermal Shock (150°C for 48 hrs)	Voltage Strength 1 KV	DIN 72551 Point 3.6.2	passed
Cold Strength (- 40°C)	Voltage Strength 1 KV	DIN 72551 Point 3.6.3	passed

Storage In Multi-Region Engine Oil (SAE 10 W-50) for 24 hrs at 90°C	Voltage Strength 1 KV	DIN 72551 Point 3.6.2	passed
Storage In Brake Fluid (Teyes ATE DOT 3) for 24 hrs at 90°C	Voltage Strength 1 KV	DIN 72551 Point 3.6.2	passed
Storage In Four Star Petrol (see DIN 51601) for 24 hrs at room temperature	Voltage Strength 1 KV	DIN 72551 Point 3.6.2	passed
Storage In Diesel Fuel (see DIN 51601) for 24 hrs at room temperature	Voltage Strength 1 KV	DIN 72551 Point 3.6.2	passed

Example 2

Composition: 100 php propylene polymer[1]

140 php Magnifin H5KV coated with AMEO-T

5 php polyethylene wax

1 polymer comprises 40 php Appryl 3060 MMS and 60 php Moplen D50-9.

The composition of Example 2 also passed the relevant tests which were carried out in relation to the composition of Example 1.

It is to be understood that the embodiments described above were by way of illustration only. Many modifications and variations are possible.

CLAIMS

1. A wire coating composition comprising polypropylene polymer or copolymer, polyethylene wax and magnesium hydroxide provided with a hydrophobic coating and wherein the wire coating composition does not contain any halogen and is essentially free of phosphorous and phosphorous compounds and phosphorous salts.

2. A wire coating composition as claimed in claim 1, wherein the coated magnesium hydroxide is present in an amount in the range from 100 to 200 php.

3. A wire coating composition as claimed in claim 2, wherein the coated magnesium hydroxide is present in an amount of substantially 140 php.

4. A wire coating composition as claimed in any preceding claim, wherein the polyethylene wax is present in an amount in the range from 1 to 20 php.

5. A wire coating composition as claimed in claim 4, wherein the polyethylene wax is present in an amount of substantially 10 php.

6. A wire coating composition as claimed in any preceding claim, wherein the hydrophobic coating material comprises an alkyl silane.

7. A wire coating composition as claimed in any preceding claim, wherein the composition comprises from 0.1 to 0.5 php of an anti-oxidant.

INTERNATIONAL SEARCH REPORT

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PCT/GB 96/00501

A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 H01B3/44

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 H01B C08L C08K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP,A,0 575 111 (MITSUI TOATSU CHEMICALS) 22 December 1993 see claims 1-10; example 14 ---	
A	EP,A,0 546 841 (NIPPON PETROCHEMICALS CO LTD) 16 June 1993 see page 7, line 33 - line 36; claims 1-22 ---	
A	EP,A,0 227 139 (SHELL INT RESEARCH) 1 July 1987 see claims 1-14; examples 3,17 -----	

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Name and mailing address of the ISA	Authorized officer
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INTERNATIONAL SEARCH REPORT

information on patent family members

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